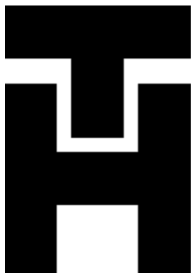


**DRAINAGE STUDY**  
**PHASE 2 – ALTERNATIVE IMPROVEMENTS**  
**CRYSTAL LAKE**  
**ALTERNATIVE 4C IMPROVEMENTS**

FOR:  
**LAKWOOD – PIRATELAND SWASH**  
HORRY COUNTY, SC

PREPARED FOR:  
**HORRY COUNTY**  
**STORMWATER DEPARTMENT**

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## BACKGROUND AND INTRODUCTION

Horry County is experiencing rapid growth and in certain places, the pace of development continues to outgrow the capacity of the existing drainage system. Flooding concerns have been voiced by many of the businesses and residents in the Lakewood-Pirateland Swash Basin (Exhibit 1). Structural flooding of several business and/or homes has been recorded on at least two occasions in the past.

The Lakewood-Pirateland Basin drains 1,560 acres including the Lakewood and Pirateland Campgrounds, Long Bay Estates, and portions of the Myrtle Beach State Park, all east of US Highway 17 Business. West of US Highway 17 Business, the basin provides drainage for the Prestwick Subdivision and Country Club, Crystal Lakes Mobile Home Park, Seagate Village (formerly part of Myrtle Beach Air Force Base), and commercial properties along the highway. Drainage is conveyed through a swash to the Atlantic Ocean.

The Horry County Stormwater Department intends to implement a three phased approach to improving drainage in the basin – including (1) the development of a hydrology and hydraulic model, (2) alternatives analysis and recommendations, and (3) implementation of the recommended improvements if deemed financially feasible.

### Phase 1

Phase 1 of the Lakewood-Pirateland Swash Drainage Project included six tasks including:

- Task 1 – Data Collection
- Task 2 – Field Reconnaissance
- Task 3 – Surveying
- Task 4 – Existing Conditions Model Development
- Task 5 – Model Calibration
- Task 6 – Phase 1 Study Findings and Report

Phase 1 of the Lakewood-Pirateland Swash Drainage Project was documented in the report *Lakewood-Pirateland Swash Drainage Study* (Thomas & Hutton, February 29, 2012).

### Phase 1 Additional Analysis

Due to certain findings of the Phase 1 report, the Horry County Stormwater Department requested additional study of the Lakewood-Pirateland Swash Drainage Basin. In particular, the County commissioned additional survey and drainage system analysis of the minor collection system draining through Strathmill Court. The additional survey and drainage system analysis work was documented in a Technical Memorandum *Lakewood-Pirateland Swash Drainage Improvements – Strathmill Court Study Findings* (Thomas & Hutton, May 3, 2012).

### Phase 2

Phase 2 of the Lakewood-Pirateland Drainage Study included the assessment of alternatives that could be implemented within the basin that would address flood issues – particularly the structural flooding of businesses along Highway 17 Business and homes in the Prestwick subdivision. Phase 2 was conducted under the following five tasks:

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- Task 1 – Alternative Projects Screening
- Task 2 – Alternative Project Evaluation
- Task 3 – Alternative Post Improvement Conditions Model Development
- Task 4 – Opinion of Probable Cost and Benefit Analysis
- Task 5 – Phase 2 Study Findings and Report

The Phase 2 assessment included developing eight (8) alternative improvement projects (some with up to three options), determining the effectiveness of each option (using the previously established ICPR model – see Exhibit 1), estimating the probable construction cost of each alternative, and providing recommended improvement(s).

The alternative improvements with the potential to alleviate the identified structural flooding were developed and screened for further assessment. The following projects were selected for further assessment as part of Phase 2 of the study.

- Alternative 1: Improvements to the existing culvert under US Hwy 17 Business
  - Alternative 1A: Addition of a 5'x10' CBC underneath US Hwy 17 Business and improvements to approximately 1,200 LF of Channel
  - Alternative 1B: Addition of a 7'x7' CBC underneath US Hwy 17
  - Alternative 1C: Addition of a 42" RCP underneath US Hwy 17 Business
- Alternative 2: Detention on a parcel adjacent the main channel (Graham Walden Tract)
  - Alternative 2A: Detention of flow entering the main channel from across Catherine Avenue (flow from the camper storage area along US Hwy 17 Business)
  - Alternative 2B: Diversion and detention of flows entering the pond/wetland area along Catherine Avenue (flows from the Prestwick Sub-division)
  - Alternative 2C: Off-line detention of flows in the main channel
- Alternative 3: Detention on a wooded area between Prestwick Phase IV and Sea Gate Village
- Alternative 4: Total and partial diversion of flows from the main channel (adjacent Sea Gate Village) to Crystal Lake
  - Alternative 4A: Partial diversion of high flows to Crystal Lake through a side-flow weir from the main channel
  - Alternative 4B: Total diversion of the flow from the main channel (draining the northern Sea Gate Village tributary)
  - Alternative 4C: Total diversion of the flow from the main channel (draining the northern and southern Sea Gate Village tributaries)
- Alternative 5: Detention in the common areas of Sea Gate Village
- Alternative 6: Modification of the pond control structure in Prestwick Phase 1

In addition to the alternative projects listed above that address the structural flooding (US Hwy 17 Business and Strathmill Court), local improvement alternatives that address potential flooding of the Strathmill Court residences were also selected for further assessment. These alternatives include:

- Alternative 7: Diversion of the local Strathmill Court drainage system to the main channel
- Alternative 8: Improvements to the local flood protection system along the main channel at Strathmill Court

The finding and recommendations from the Phase 2 work included the following:

*Based on the results of the proposed conditions ICPR modeling and the opinions of probable construction cost for Alternatives 2A, 2B, 2C, 3, 4B, 5, and 6, it appears that with the limited improvement in flooding conditions and the relatively high cost that these alternatives are not viable for implementation and thus are not considered further.*

*Only Alternative 1A totally addresses the structural (including garage) flooding (up to the 100-yr rainfall event) reported and as identified by the existing conditions modeling. The other alternatives that had significant impact on flooding included Alternatives 1B, 1C and 4C. Alternative 4C's opinion of probable construction cost does not include a cost for the lake bottom excavation/dredging. This cost would be significant (approximately \$1M to \$3M), which would render the alternative to be cost prohibitive. In addition, Alternative 4C would require a radical modification of the lakes operation (lower NWL by approximately 4.5 feet), which could be unacceptable to local residents.*

*Alternative 4A provides moderate improvement with a relatively inexpensive capital cost, but does not address structural flooding through the 100-yr rainfall event. Alternative 8 could address flooding at the Strathmill Court locations (up to the 100-year event), but would most likely need to be implemented by private entities, since most of the infrastructure is on private lands without a dedicated easement to a public entity.*

*It is recommended that the County pursue the implementation of Alternative 1A as a long term solution to structural flooding in the watershed and possibly implement Alternative 4A as an interim, partial solution to flooding the watershed.*

#### Phase 2 Additional Analysis

Alternative 4A would involve the "lowering" of Crystal Lake. The Lake's current normal water level (NWL) is approximately 13.3 (ft. NGVD 88). The existing contributing area to Crystal Lake is relatively small (92.7 acres) and thus does not receive a lot of runoff. The Lake's existing control structure (which seldom outflows due to the low runoff amount and large storage volume), has an overflow weir at elevation 17.0 and control structure outflow pipe at elevation 13.5. The bottom elevations vary (in fact, "islands" are sometime formed in the Lake at low water), but averages approximate 10.6.

To allow more of the adjacent area to flow into the Lake, the operation and control of the Lake would be lowered such that the NWL would be elevation 10.0. This would allow the runoff from Seagate Village to be diverted to the Lake, increasing the contributing area to approximately 397.0 acres. The runoff from the increased contributing area would be temporarily detained and release back to the main drainage system at a lower rate, preventing the flooding currently experienced downstream.

To lower the NWL of the Lake would require the bottom of the Lake to be lowered to an elevation to maintain a normal depth of approximately 6 feet to prevent the growth of aquatic plants. Thus, the bottom of the Lake would be lowered to elevation 4.0. In addition to the lowering of the Lake, various off-site (that is, not within Crystal Lake) improvements would be needed to divert the runoff from Seagate Village into Crystal Lake.

Pursuant to a meeting between Thomas & Hutton, Horry County and the Jackson Companies (owner of Crystal Lake), the County decided to further study the Crystal Lake alternative (Alternative 4C). This alternative, although significantly more expensive than the recommended alternative (Alternative 1A), has other potential benefits and would lessen peak flows downstream. The additional benefits may include: improved water quality downstream, additional depth/recreation opportunities at Crystal Lake, and additional water source for the Prestwick Golf Course since it draws from Crystal Lake. Alternative 1A would increase flows and thus peak water surface elevations downstream of US Hwy 17 Business, potentially aggravating flooding. Horry County requested Thomas & Hutton to perform additional assessment of the Crystal Lake option to include assessing potential construction approaches, refine the conceptual design of the proposed improvements, and refine the opinion of probable construction cost for the proposed improvement. The additional assessment also includes a topographic/bathymetric survey of the lake and geotechnical investigation. The following sections summarize the findings of the addition analysis conducted under Phase 2.

### **BATHYMETRIC/TOPOGRAPHIC SURVEY**

Thomas & Hutton conducted a limited bathymetric and topographic survey of Crystal Lake. The topographic survey was from the top of bank to the water level of the lake. Readily visible above ground improvements including storm drainage outfall pipes and structures within the survey limits were also surveyed. The bathymetric survey was conducted roughly on a 200-ft. by 200-ft. grid across the lake. The bathymetric and topographic survey measurements were merged to produce a composite survey of the entire lake within the top of bank. The survey data was further combined with LiDAR topography data of the surrounding area to produce a single existing conditions surface.

The water surface elevation of the lake at the time of the survey was approximately 13.3. The elevation of the bottom of the Lake varied from approximately 5.0 to 14.6, with an average bottom elevation of approximately 10.6. The elevation of the bottom of the Lake is highly variable; however, the level of survey (200-foot grid) may not accurately represent all topographic features in the Lake.

### **GEOTECHNICAL EXPLORATION**

A geotechnical exploration was conducted to evaluate subsurface conditions at the site as they relate to the potential dredging and excavation activities and also to determine the potential reuse of excavated materials. The geotechnical exploration included four standard penetration test (SPT) borings at widely-spaced locations around the perimeter of the lake. Soil sampling and penetration testing was performed. Subsurface water levels were measured and the recovered soil samples were classified and some of the recovered soil samples were subjected to laboratory tests. Refer to Appendix A for the report prepared summarizing the findings of the geotechnical exploration.

### **CONSTRUCTION ALTERNATIVES ASSESSMENT**

Thomas & Hutton investigated and assessed viable construction alternatives for the proposed improvements to Crystal Lake. Various dredge/excavation methods were discussed with several local and regional contractors to refine the construction methods. Essentially, two viable methods were determined for the construction: 1) mechanical excavation and haul by truck from the Lake (that is pumped to control runoff and groundwater seepage) and 2) hydraulic dredging of the lake via a barge mounted dredge floated on the Lake.

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Two options as to “handling” the excavated/dredged material were also assessed. Option 1 would include the excavation/dredging of the entire Lake and stockpiling the material on an adjacent site and Option 2 would include the excavation/dredging of a portion of the Lake and filling a portion of the Lake (so as to result in a “balance” project, i.e. no off-site transport of material). Thomas & Hutton also contacted two local mass excavation/grading contractors and two regional dredging contractors to discuss various components of the project, potential construction methods and issues, and estimated unit costs for construction.

Based on this input and other factors, Thomas & Hutton refined Alternative 4C to include Option 1 (excavation/dredge to off-site location) and Option 2 (excavate/dredge on-site). Option 1 is further divided into sub-options by the location of the off-site stockpile/dredge disposal site. The Jackson Company owns Crystal Lake and the land adjacent it (undeveloped area to the northwest of the Lake). Material hauled off-site from Crystal Lake could be placed on (or in) an existing borrow site/pond (commonly referred to as the 15.0 acre Crystal Lake borrow site). The material could also be stockpiled on a new site cleared/constructed on the adjacent property. These options are discussed further in detail below.

**REFINED CONCEPTUAL DESIGN**

Based on the findings of the previous tasks and other input, the proposed conceptual improvements (Crystal Lake Alternative 4C) were further refined from the Phase 2 Report. The conceptual plan for Option 1 is illustrated in Exhibit 2. The conceptual plan for Option 2 is illustrated in Exhibit 3. The off-site improvements to divert the flow coming from Seagate Village are illustrated in Exhibit 4.

The original ICPR alternative model established for Phase 2 was refined to reflect the alternative design and confirm that the recommended configuration will meet the flood improvement goals of the project. Table 1 summarizes the existing and proposed Alternative 4C – Option 1 peak water surface elevations and compares them to the historically flooded structures. Table 2 summarizes the existing and proposed Alternative 4C – Option 2 peak water surface elevations and compares them to the historically flooded structures.

The revised ICPR modeling indicates that both Alternative 4C Options prevent first floor structural flooding of the historically flooded structures (Camper County and 1284/1288 Stratmill Ct.) up to and including the 100-year storm event. However, the garage area of 1288 Stratmill Ct. may be subject to flooding for the 100-year event for Option 1 and for the 50-year and 100-year events for Option 2.

**OPINION OF PROBABLE CONSTRUCTION COST**

Based on the refined concept plans for Alternative 4C – Option 1 and Option 2 and the off-site improvements, the opinion of probable construction costs were refined. Material quantities were estimated from the revised concept plans and units costs are based on discussions with the local and regional contractors and on recent bids and contracts for similar work as found in T&H’s records for recent projects in the area. The detailed opinions of probable construction cost are included at the end of this report and are summarized in Table 3.

The opinions of probable construction cost were calculated as follows:

- Alternative 4C – Option 1A.1 - Full Lake Dredging - New Disposal Site
- Alternative 4C – Option 1A.2 - Full Lake Dredging - Existing Borrow/Disposal Site
- Alternative 4C – Option 1B.1 - Full Lake Excavation - New Stockpile Site

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- Alternative 4C – Option 1B.1 - Full Lake Excavation - Existing Borrow/Stockpile Site
- Alternative 4C – Option 2A - Partial Lake Dredging / Partial Lake Fill
- Alternative 4C – Option 2B - Partial Lake Excavation / Partial Lake Fill
- Alternative 4C – Off-site Improvements

For clarification, Alternative 4C was the original alternative from the Phase 2 report that proposed the diversion of the Seagate Village area to Crystal Lake and the modification of Crystal Lake to function under the proposed conditions and provide flood protection downstream. For consistency, that alternative nomenclature was held constant for this report. Options 1 and 2 refer to whether the Lake would be excavated fully (Option 1) or partially excavated and partially filled (Option 2). A and B refers to method of construction – dredging (A) or mechanical excavation and hauling (B). The sub-alternatives under Option 1 (i.e. 1A.1 or 1A.2) refer to the location of the off-site material disposal (for dredging) or stockpile (for excavation and haul). Constructing a new off-site disposal/stockpile site is signified by .1 and utilizing an existing site is signified by .2. The opinion of probable construction costs are included as the end of this report.

The complete Alternative 4C project would include the Off-site Improvements and one of the Lake (full or partial) dredging or excavation Options.

## FINDINGS AND RECOMMENDATIONS

As discussed in the Background and Introductions section, drainage improvement Alternative 4C would alter the drainage pattern from Seagate Village and divert the stormwater flows from the existing main channel to Crystal Lake. This modification would increase the Crystal Lake contributing drainage area from approximately 97 acres to 397 acres. The alternative improvement would also include the modification of Crystal Lake to make it function in a way as to 1) allow positive drainage from Seagate Village, 2) temporarily store the runoff before releasing it to the main channel and 3) allow the Lake to continue to function as an amenity to the Crystal Lake mobile home park. The existing NWL would be lowered from approximately elevation 13.3 to elevation 10.0, and the bottom would be lowered from approximately elevation 10.6 to elevation 4.0.

The Lake modification could be implemented either fully (Option 1) or partially (Option 2). Option 1 would modify the entire Lake (approximately 37.0 acres at the existing NWL of 13.3) by either dredging or mechanically excavating the Lake deeper. Option 2 would include the partial dredging (or excavating) and the partial filling of the Lake. Option 2, as proposed would be a "balanced" project – i.e. that amount of excavation is equal to the amount of fill and thus no material need to be transported off-site. Option 2 would result in a Lake with a water area of approximately 23.6 acres (at the new NWL of elevation 10.0). This option would also "create" approximately 13.6 acres of new upland (filled lake) area measured at new top of bank.

Option 1 and Option 2 provide essentially the same level of flood protection benefit (Refer to Tables 1 and 2). Both options are predicted to protect the historically flooded structures (1284/1288 Stratmill Ct. and Camper Country) from structural flooding (flooding above the finished floor elevation) up to and including the 100-year storm event. However, both options would not prevent flooding of the lower garage area of 1284 Stratmill Ct. for events larger than and including the 50-year storm event. Option 1 provides an approximate 0.5 foot lower water surface elevation (WSE). Option 1 improves peak WSEs in the main channel by approximately 2.0 feet for all events and Option 2 improves them by approximately 1.5 feet.



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As discussed in the Opinion of Probable Construction Cost section, the total Alternative 4C improvement project would include the off-site improvements (estimated at a cost of \$439,000) and one of the option sceneries (estimate at a cost of (\$1,131,000 to \$2,618,000). Thus the minimum cost of Alternative 4C would be \$1,570,000 (Option 2B and Off-site Improvements) and the maximum would be \$3,057,000 (Option 1A.1 and Off-site Improvements). Given that the various options result in similar flood protection benefits, the recommended improvement should be the most cost efficient. Therefore it is recommended that **Option 2B** with **Off-site Improvements** be implemented.

Additional project considerations are discussed below.

Permitting

Preliminary contact was made with the US Army Corp of Engineers (wetlands) and SC Department of Health and Environmental Control (mining) to assess potential permitting issues. The USACOE could not provide an opinion as to the potential need for a wetland disturbance (Section 404) permit. However, it was indicated that if the Lake was not excavated from wetlands, that it most likely would not require a wetlands disturbance permit. Of course, a full wetland verification and jurisdictional determination should be conducted prior to proceeding with the project. SCDHEC indicated that a mining permit would probably not be required, but several variables (like the commercial sale of the material) could affect that determination. Full coordination with SCDHEC should be conducted prior to initiating the project. Also, a NPDES Construction General Permit (SDHEC) and Coastal Zone Consistency (OCRM) would be required for the project.

Effect on Adjacent Properties

Crystal Lake is surrounded by residential properties essentially on all sides. These properties may be affected by the construction of the proposed improvements. The construction of the off-site improvements is relatively small and given proper considerations, any negative impacts on adjacent properties could be mitigated. The excavation or dredging of Crystal Lake could affect adjacent properties negatively while in operation. Excavation and dredging operations could take up to four (4) months to complete. Dredging may be more acceptable since the Lake would remain active (i.e. full of water), noise would be relatively minor, and dust and truck traffic would be eliminated. However, give the proper consideration and construction practices, the effects of the excavation of the Lake could be minimized.